Understanding the coastal zone

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Australia's love affair with the sun and sea has brought immense pressure on coastal ecosystems which, if not sensibly managed, could undermine the delicate relationship between human activity and the environment.

Pressure on the coastal area comes mainly from rapid population growth along the coastal strip. In the past two decades, townships have sprouted in areas previously uninhabited, thanks to the lure of a leisurely lifestyle. Between 1971 and 1991, the population of non-metropolitan coastal areas rose by 95%, from 2.1 million to 4.1 million. Counting the major coastal cities, close to nine out of 10 Australians now live in the coastal zone.

Population growth inevitably brings industrial development, both rural and urban. Newer industries such as tourism and aquaculture are also placing pressure on coastal resources.

Governments, industry and the community realise that the coastal zone suffers from development fatigue. During the last five years, there has been a flurry of research activities along the coastal strip to determine the nature and extent of the problems. While research projects are being conducted by many groups, they are driven by a common motive: to develop science-based strategies for managing development in a way that will sustain the environment in the long term.

Research is being conducted by the universities; industrial firms; Commonwealth departments and entities such as CSIRO and the Australian Institute of Marine Science; state utilities such as Sydney Water and Melbourne Water; and by private groups such as the Surfrider Foundation.

CSIRO's Coastal Zone Program was set up to draw together work from eight divisions already active in coastal research. Its aim is to equip managers and users of coastal areas with tools and techniques for making decisions based on the most recent scientific findings.

'We've set ourselves an ambitious target: to identify the factors affecting the health of the waters flowing through coastal catchments and estuaries, to quantify the movement of contaminants through those waters, and to link these descriptions together in predictive models,' says program coordinator, Dr John Finnigan, head of CSIRO's Centre for Environmental Mechanics.

Most Australian research on the coastal zone is based on the philosophy that effective coastal management requires a thorough understanding of the ecosystem, how it works and how it responds to human activity. Dr Finnigan says understanding the ecosystem and predicting its response to human activity is difficult because of the rapid changes in the type of pressures impinging on the coast.

'If all human and industrial activities in the coastal zone were frozen at 1995 levels, ecosystems will continue to change because they will still be reacting to pressures introduced years before,' Finnigan says.

'But these activities are not frozen, they are accelerating. This makes understanding and predicting changes in coastal ecosystems doubly difficult. Nevertheless, it is this ability to forecast the results of changing the inputs to the system that managers want most urgently, and what the program aims to deliver.'

The three-year old program combines CSIRO research with that of private and government collaborators. It begins with the observation that most problems in the near-shore region relate to activities on land, so the land-sea connection must be central to the way these problems are approached.

The program aims to produce predictive, quantitative models of the key steps that translate activities on land – such as agricultural run-off or industrial discharges – into reduced water and sediment quality and inputs on coastal biota. The research focusses on estuaries and their catchments as these are the main conduits for materials

A program of many parts

Research being carried out as part of Coastal Zone Program is grouped under five broad headings.

- ***Land use and water quality*** **concentrates on the inputs to rivers from agricultural, urban and point sources.**
- ***In-stream processes*** **looks at chemical and physical transformations as contaminants move through rivers to the estuary.**
- ***Estuarine mixing models*** **aims to build the complex computer programs that describe how contaminants are moved about the estuary under the influences of winds, tides and river flow, and the chemical changes that happen to them.**
- ***Sediments*** **looks at the many physical, chemical and biological processes that mediate the transfer of contaminants between the sediments and the water column.**
- ***Eutrophication and filter feeders*** **studies the impact of raised nutrient levels on animals at the lower end of the marine food chain, often the first indicators of environmental impact.**
- ***CAMRIS*** **overarches the other five projects, and is a continent-scale GIS for the entire Australian coast. It will increase enormously our ability to see the problems in a national perspective.**

entering the coastal zone from land. They are also the location of most population growth and much productive agricultural land. Their waters are also the ones most heavily affected by pollution.

The program addresses the key steps under five broad headings (see box story opposite) starting on land in the catchment, moving through streams and rivers to the estuary and the bottom end of the food chain. As well as these process studies, work on a continent-scale coastal geographic information system (GIS) is designed to place these problems in a national perspective.

Each key area has one or more projects in different parts of the coast from Perth to Townsville where cooperation with local managers and users ensures that the emerging tools and techniques relate to local problems.

For example, the team working in Hobart's Derwent River is advising Hobart councils on the siting of new sewage outfalls, and work on acid sulfate estuarine soils has led to the adoption of management guidelines by coastal managers at both state and local levels in northern New South Wales.

Finnigan says that while individual projects have immediate relevance to their local areas, the next stage is to integrate them into a single description of the catchment-estuary system, with all the physical, chemical and biological links quantified in a compatible way.

This package of models then needs to be brought to bear on a single system in Australia in a trial project to test its effectiveness. So far only one other program has attempted this Herculean task in Australia. This is the $11.2m Port Phillip Bay Environmental study, managed by CSIRO's Institute of Natural Resources and Environment.

The study, begun in 1992, is a four-year project investigating Port Phillip Bay's ecology, physical processes, and nutrient and toxicant levels. It will identify the sources, concentrations and dispersal of pollutants in the bay. This information will reside on a permanent database available to assist authorities responsible for bay management.

What is evident in both the Coastal Zone Program and the Port Phillip Bay study is that the unique character of the Australian coastal zone, such as its fragile soils, high annual variations in river flow and naturally nutrient-poor waters, means that many of the predictive models used overseas are of no use here. The program will have succeeded if it can make major strides to fill this gap.

The coastal zone: a complex system

Coastal water quality is inextricably linked to inputs from the land. Pollutants from point sources like sewage treatment and industrial plants add to the nutrients, pesticides and sediments in the run off from agricultural land, and heavy metals and hydrocarbons in the surface run off from cities.

The contaminants are continually exchanged between the water column and the bottom sediments where they can accumulate for months or years, to be released slowly even after the offending source has been removed, or suddenly during high river flows. Understanding interactions and feedbacks between all these processes is crucial to managing the coastal zone.